ABSTRACT

Nanomaterials are being implied these days for the advancement in the fields of health and medical sciences. They confer significant potential to fabricate biosensors and field-effect transistor based biosensors (bioFETs). The salient features of such biosensors are miniaturized size, sensitivity, selectivity and abrupt response upon interaction with target analyte. Therefore, emphasizing the nature of the graphene, copper oxide and cobalt oxide as nanomaterial, the primary focus of this work was to harness their potential for the formation of biosensors for the detection of cholesterol, uric acid, glucose and dopamine within biological system. The graphene sheets were grown by chemical vapor deposition while, metal oxides were synthesized by following sol-gel and hydrothermal methods. After synthesis, biosensing devices were fabricated and characterized. Initially, the devices were characterized to record the control reference parameters. After the immobilization of their respective bio-receptors, different target analytes were analyzed for the detection pattern.

For the development of cholesterol biosensor, cholesterol oxidase was immobilized on the graphene electrode as bio-receptor. The enzymatic graphene integrated platform was found to be very selective, sensitive and fast towards cholesterol detection. Cholesterol functionalization on electrode surface produced n-doping. A significant increase in the charge carrier concentration ($\sim$2000 $cm^2V^{-1}s^{-1}$to $\sim$3900 $cm^2V^{-1}s^{-1}$) was observed on increasing cholesterol concentration up to 10 mg/ml. The electron mobility was found to be enhanced 2-fold. Moreover, uricase and glucose oxidase were utilized as enzymatic bio-receptor agents for selective determination of uric acid and glucose. For this, production of uricase and glucose oxidase from *Aspergillus niger* strains was carried out through submerged fermentation and were partially purified using ammonium sulphate precipitations. The blood serum samples were tested for the concentration evaluation by using these fabricated devices and locally produced enzymes. The glucose oxidase functionalization on electrode surface improved the electron mobility up to 4-fold which ultimately enhanced the performance however, in case of uric acid the electron mobility observed to be enhanced by 49%. The progressive enhancement in the mobilities with increasing analyte concentration and the long-time stability over the range of different time periods indicated that biochemical treatment was a convenient approach to tailor the electrical properties of various FET devices.

Two approaches were followed to fabricate the sensing devices i.e. graphene-based biosensors and electrochemical biosensing using copper oxide and cobalt oxide as electrode material. In electrochemical biosensing, the pattern of detection of glucose and dopamine were analyzed as enzyme-less approach. In pursuit of non-enzymatic glucose detection, electro-oxidation mechanism was investigated by cyclic voltammetry and chronoamperometry. The as-prepared sample was tested with and without glucose in 0.1 M NaOH electrolyte revealing a high catalytic performance with wide linear range of 1 to 6 mM. Sensitivity and LOD of CuO was studied by calorimetric curve and is found to be 55.28 μA/mM and 0.045 μM, respectively. For the determination of dopamine in physiological environment, spiked urine and blood samples were analyzed. The maximum recovery ratios attributed the working efficiency of Co_3O_4 polyaniline nanocomposite biosensor. The selectivity of non-enzymatic biosensors was confirmed by studying the effect of common interfering agents such as uric acid, glucose, ascorbic acid and dopamine by incorporating them within sensing channel. In future, other analyte materials such as toxins, pesticides and explosives posing harmful effects on the environment can be detected in trace amounts using graphene nanosheets. For the potential applications of nanomaterials in bioimaging and drug delivery it is inevitable to further study biocompatibility to assess their toxicity to curb deadly diseases for which therapeutic tools have not been explored.